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NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

FRUIT AND POTATO DISEASES

SPOT DISEASE OF APPLE

BY H. H. LAMSON

NEW HAMPSHIRE COLLEGE
OF
AGRICULTURE AND THE MECHANIC ARTS
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Experiments in the Treatment of Fungous Diseases of Fruit and Potatoes

BY H. H. LAMSON

The diseases with which this Bulletin is concerned are those known as fungous diseases. They are not due to insects, which belong to the animal kingdom, but to members of the vegetable kingdom—that is to say, plants. These disease-producing plants belong to the class known as fungi, and as they grow upon other plants, they are called parasitic fungi. They are so small that their nature cannot be made out by the naked eye, so that it is not strange that they are not so well understood by the majority of people as are insects. The parasitic fungi grow at the expense of the plant on which they live, and cause, in many cases, serious damage; and in the case of cultivated plants, great pecuniary loss. It has been found that many of these diseases may be largely prevented by spraying with some substance which is harmless to the cultivated, but poisonous to the fungous, plant.

DISEASES OF THE APPLE AND PEAR

The most serious fungous disease of the apple and pear is usually the *scab*. This disease appears on both the fruit and the foliage. On the fruit it appears as dark green or almost black spots, with a velvety surface. The spots are circular in outline, and occur separately or run together in irregular patches, often covering a large portion of the surface. The spots are thickened, and slightly raised above the surface, so that the term *scab* is very applicable to the disease.

A fruit which is badly affected with the scab is usually deformed or one-sided, and frequently cracked so as to be worthless. Certain varieties of both apples and pears are more

liable to be attacked by this disease than others. Upon the foliage the scab appears as black or dusky irregular patches upon the upper surface of the leaf. The scab is caused by a parasitic fungous plant, which finds its proper soil on the fruit or leaf. The disease is spread by spores which develop on the surface of the scab spots.

The amount of damage done by the scab varies from year to year. In some years it is very prevalent, while in others it does comparatively little injury.

The scab is one of the diseases which can be most effectually prevented by spraying with a fungicide such as the Bordeaux mixture.

During the last three years the Baldwin apple, which is very largely grown in southern New Hampshire, has been badly affected by another fungous disease entirely different from the scab. This disease is characterized by the appearance on the surface of the apple of numerous small brown spots, varying in diameter from a sixteenth to an eighth of an inch (see cover). The spots are slightly sunken or depressed, so that the surface has a pitted appearance. They suggest the beginning of rot, but they do not seem to increase in size ordinarily, though occasionally they do. They do not affect the tissues of the apple deeply, and the principal damage done by the disease seems to be the disfigurement of the fruit, which is often great, rendering an otherwise perfect apple a second.

The following experiments show the effect on this disease of spraying with Bordeaux mixture.

Experiment I.—Season of 1895, on Baldwin apples:

A plot of trees A was sprayed four times with 1 to 10 Bordeaux mixture (1 to 8, 1 to 10, 1 to 12 Bordeaux mixture mean that 1 pound of blue vitriol was used for every 8, 10, or 12 gallons of water), twice before blossoming, May 4 and 10, and twice after blossoming, May 28 and June 14.

A plot of trees B was sprayed with 1 to 10 mixture once before, May 10, and twice after blossoming, May 28 and June 14.

A plot of trees C was sprayed with 1 to 8 mixture three times, May 10, 28, and June 14.

A plot of trees D was sprayed with 1 to 12 mixture three times, May 11, 29, and June 15.

At the first spraying after the blossoms had fallen, May 28, 4 ounces of Paris green were added to each 50 gallons of Bordeaux mixture for the codling-moth. This experiment is therefore a good illustration of a combined treatment for fungi and insects.

The apples, when gathered, showed the following results:

Apples from unsprayed check trees, as well as from the sprayed trees, were examined one by one and counted. The first table compares the total number of apples unsprayed and sprayed.

	Unsprayed.	Sprayed.
Free from spots and worms	19 per cent.	82 per cent.
Spotted	55 "	3 "
Wormy	58 "	15 "

Of the unsprayed, 9⅓ per cent. were graded as No. 1's.

Of the sprayed, 53 per cent. were graded as No. 1's.

The following table compares the effects of the different modes of treatment of the sprayed trees on the spot disease:

	Plot A.	Plot B.	Plot C.	Plot D.
Free from spots .	95 per cent.	99 per cent.	96 per cent.	99 per cent.

These results show the efficiency of the Bordeaux mixture in preventing the disease, with but little difference between the different strengths and times of applying it.

Experiment II.—Season of 1896, on Baldwin apples:

Plot 1. Trees sprayed twice with 1 to 10 Bordeaux mixture, once before blossoming and once after.

Plot 2. Trees sprayed with 1 to 10 Bordeaux mixture once after blossoming.

Check trees unsprayed.

Result:	Unsprayed.	Sprayed.	
		Plot 1.	Plot 2.
Free from spots . . .	32 per cent.	90 per cent.	82 per cent.
Spotted	68 "	10 "	18 "

This shows a slight gain in favor of the trees sprayed twice.

In 1896 another disease was very prevalent on apples, and together with the spot disease rendered much of the crop very

unsightly. This disease is characterized by dirty or sooty spots on the skin of the apple. The spots are roundish in outline; varying much in size, they often run together, covering nearly or quite the whole surface of the fruit. If drops of water containing soot or lampblack were allowed to evaporate on the surface of the apple, they would produce an appearance resembling this disease. Its fungous nature, however, is clearly revealed by the microscope. It is entirely superficial and, as in case of the spot disease, the principal damage produced by it is disfigurement. This disease is frequently observed on Greenings and Northern Spies, but in 1896 it attacked many other varieties, among them the Baldwin.

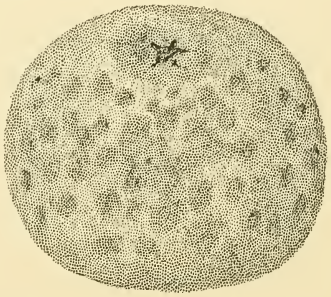

FIG. 2.—Apple affected with sooty disease.

The sooty disease frequently attacks pears; it is especially bad on Beurre de Anjou and Lawrence. In case of the latter, the favorable effect of spraying with Bordeaux mixture has been reported on in a previous Bulletin of this station (No. 27).

In 1896, although no exact count was made, it is safe to say that the sprayed apples showed 75 per cent. less of the disease than the unsprayed.

BLACK KNOT OF PLUM

It is probable that plums might be raised with profit in many parts of New Hampshire, if it were not for the disease known as *black knot*. Until recently it has been thought that the only

efficient remedy for it was to cut off and burn the knots, but from experiments at several stations, it seems probable that the disease may be controlled by spraying with a fungicide. In order that the spraying may be effective, it is necessary to know something of its life history. Black knot is caused by a fungous plant which grows in the inner bark of the tree, causing it to swell and crack open. The fungous plant reproduces itself by means of spores, of which there are two principal kinds. One kind is known as the summer spore, and the other as the winter spore.

The summer spores are formed soon after the bark cracks open in the spring, in May or June, and serve to spread the disease at that time. After this form of spore has disappeared, a change takes place in the young knot, in which it assumes its well-known appearance of a black swelling on the twigs or branches. The surface of the black swelling is now thickly studded with minute pimple-like projections, in the interior of which are produced the winter spores. This form of spore is mature and capable of germination in February or March and serves to spread the disease early in the spring, when the leaves and young shoots are making their appearance.

The spraying against this disease should be done at such a time as will bring the fungicide in contact with the spores before they have time to germinate and infect the trees. Hence it is recommended that the trees be sprayed early, before growth begins, and again when the buds are ready to burst. These sprayings are to destroy the winter spores. To destroy the summer spores, the trees should be sprayed about the last of May, and again about the middle of June. The best fungicide for this purpose is the Bordeaux mixture. If this treatment is faithfully followed, it is probable that the disease will, to a large extent, be prevented. If spraying is not done, the trees should be carefully examined in the spring and fall, when the leaves are off, for knots or swellings; these, when found, should be removed and burned. Where large wounds are made by this pruning, they should be covered with paint of some kind.

It would be well if there were a law in New Hampshire, properly enforced, compelling each fruit grower to keep his

trees free from the black knot. The wild cherries are affected with the same disease, and must be attended to if the disease is to be stamped out.

DISEASES OF THE POTATO

The potato is subject to three serious diseases, viz., the *early blight*, the *late blight*, and the *scab*, all caused by parasitic plants or fungi. As their names indicate, the two blights, or rusts, as they are frequently called, differ in their time of appearance. The early blight may appear in June upon early potatoes. Upon late potatoes it does not appear usually before the middle or last of July. The late blight appears about the first of August. Besides this difference in time of attack, the two diseases possess distinct characteristics, which may be readily made out by any one on a careful examination of the affected vines. The early blight produces dark brown, sharply defined spots upon the leaves, which increase in number and size until the whole leaf may be destroyed. This disease does not attack the tubers. The late blight is characterized by the rapid withering and death of the leaves, without the appearance of sharply defined spots. It usually begins at the margins, and soon involves the whole leaf. Upon the under side of the leaves, along the line separating the dead from the living portion, may be observed a whitish, mold-like growth, which the microscope shows to consist of the spore stalks of the fungus plant which is causing the trouble. This white mold, the absence of well-defined spots, and the rapid dying of the leaves, serve to distinguish the late blight from the early. We frequently find vines affected with both diseases at the same time. The blights can be successfully treated by spraying.

The following are results obtained in treating potatoes for early blight:

	Bushels per acre.	Gain from spraying.
Sprayed four times with 1 to 10 Bordeaux mixture	237	
Unsprayed adjacent plot	185	52 bushels.
Sprayed twice with 1 to 10 Bordeaux	352	
Unsprayed adjacent plot	287	65 "
Sprayed three times with 1 to 10 Bordeaux	337	
Unsprayed adjacent plot	255	82 "
Sprayed three times with 1 to 10 Bordeaux	320	
Unsprayed adjacent plot	246	74 "

These results fairly represent the value of spraying, but as the depredations of the fungous diseases vary so much from year to year, and with other varying conditions, more favorable as well as less favorable ones may be obtained.

The *scab* of potatoes is caused by an organism which, while of a vegetable nature, differs considerably from those causing the blights. The scab of the potato has no similarity or relation to the above-described scab of the apple. The appearance of scabby potatoes needs no description. The organisms causing the disease may be present in the soil or upon the seed used. It has been found that certain forms of fertilizers, while they do not cause the disease, produce a condition of the soil which is especially favorable for its development. These fertilizers are stable manure, ashes, and lime or plaster.

Treatment of the scab. If possible, seed free from scab should be planted, but under ordinary conditions it is difficult to be certain that the seed is wholly uncontaminated. Potatoes should not be planted a second time on soil which has previously produced a scabby crop. The use of the above-mentioned fertilizers should be avoided. Seed may be freed from all or most of the germs by soaking in a solution of corrosive sublimate. This treatment may be carried out in the following way: Dissolve corrosive sublimate in water at the rate of one ounce to eight gallons of water. Keep this solution in a wooden vessel; a barrel, half barrel, or wash-tub will answer the purpose. Put the potatoes to be treated in a coarse sacking bag, and plunge in the solution; let them remain for an hour and a half, moving them about occasionally to insure thorough wetting; then dry the potatoes, and they are ready for planting. Care should be taken that they do not become contaminated again by dirt from untreated potatoes. It should be remembered that corrosive sublimate is a violent poison if taken internally, therefore care should be taken in using it.

In 1895 the following experiment was made, to ascertain the effect of different fertilizers on the development of the scab: Four plots of 4 rows each were planted.

Plot 1 was fertilized with commercial fertilizer.
Plot 2 was fertilized with stable manure.
Plot 3 was fertilized with plaster.
Plot 4 was fertilized with wood ashes.

The seed used was very scabby. Two rows of each plot were planted with the seed untreated; the other two rows, with seed soaked in solution of corrosive sublimate, as above described.

When dug, the potatoes showed the following result: The figures indicate the per cent. of scabby ones.

	Commercial fertilizer.	Stable manure.	Plaster.	Ashes.
Treated .	8 per cent.	3 per cent.	12 per cent.	10 per cent.
Untreated .	37 "	14 "	56 "	41 "

These results show the beneficial effect of treating the seed, but do not fully bear out the statement made above in regard to the effect of the different fertilizers.

BORDEAUX MIXTURE

The Bordeaux mixture continues to recommend itself as the best all-round remedy for fungous diseases. It is efficient, it is cheap, and it is easily prepared when one once gets the "hang" of it and is willing to take pains. Directions should be carefully followed by those who are unfamiliar with its preparation.

The ingredients of the Bordeaux mixture are blue vitriol, lime, and water. The ingredient which kills the fungus is the blue vitriol. The purpose of the lime is to prevent the injury to the foliage which a simple solution of blue vitriol would cause.

The proportion of the ingredients may be varied considerably. The formula which was recommended in Bulletin 27 of this Station still seems to us a satisfactory one, namely:

Blue vitriol	1 lb.
Lime, fresh	⅔ "
Water	10 gals.

As the quantity most frequently prepared would be a barrel, the formula may be given as follows:

Blue vitriol . . .	5 lbs.
Lime	3⅓ lbs.
Water	1 bbl. (45 to 50 gals.)

For convenience in weighing, 3½ lbs. of lime may be used. This makes what we have designated as a 1 to 10 mixture. The one described below by Mr. Galloway is a 1 to 8¼ mixture. It will not do to throw these ingredients together haphazard and expect a good result. The blue vitriol should be dissolved separately; this can be done with cold water, but it requires considerable time and is best done in the way described by Mr. Galloway. When wanted for immediate use, it may be dissolved rapidly in hot water, two quarts of which will dissolve a pound. A good way is to prepare a stock solution in quantity beforehand, making it of such strength that a half gallon or a gallon will contain one pound.

Only fresh lime should be used. Select the firm, uncrumbled lumps. Slack it by adding water slowly, just enough to keep it from burning or becoming dry until the lumps are all broken up, then add water enough to make a thin paste. The method of mixing the solution of blue vitriol and the lime recommended by Galloway is the ideal one, and even when it is not convenient to follow it in detail, the principle involved should be followed; that is, to dilute both the blue vitriol and the lime as much as possible before mixing.

If the quantity of *fresh* lime given in the formula be used, it will not be necessary to test the mixture. But it is often convenient to make up a considerable quantity of lime paste, and inconvenient to measure it afterwards; then a test which will tell when enough lime has been used will be convenient.

Dissolve a lump of yellow prussiate of potash (which may be obtained at any drug store) as large as a chestnut in a gill of water, and keep in a bottle; add a few drops of this to a saucerful of the prepared mixture. If a brown color appears, add more lime to the mixture, and test again. When sufficient lime has been used, no brown color will appear on applying the prussiate solution. Other tests are given below.

The following explicit directions for making the Bordeaux mixture were written by Mr. B. T. Galloway, of the United States Department of Agriculture: In a barrel or other suitable vessel place twenty-five gallons of water. Weigh out six pounds of copper sulphate, then tie the same in a piece of coarse gunny sack, and suspend it just beneath the surface of the

water. By tying the bag to a stick laid across the top of the barrel, no further attention will be required. In another vessel slack four pounds of lime, using care in order to obtain a smooth paste, free from grit and small lumps. To accomplish this, it is best to place the lime in an ordinary water pail and add only a small quantity of water at first, say a quart or a quart and a half. When the lime begins to crack and crumble and the water to disappear, add another quart or more, exercising care that the lime at no time gets too dry. Toward the last, considerable water will be required, but if added carefully and slowly, a perfectly smooth paste will be obtained, provided, of course, the lime is of good quality. When the lime is slacked, add sufficient water to the paste to bring the whole up to twenty-five gallons. When the copper sulphate is entirely

FIG. 3.—Making Bordeaux mixture. Pouring together the lime milk and copper sulphate solution.

dissolved and the lime is cool, pour the lime milk and copper sulphate solution slowly together into a barrel holding fifty gallons, as shown in Fig. 3. The milk of lime should be thoroughly stirred before pouring. The method described ensures good mixing, but to complete this work the barrel of liquid should receive a final stirring, for at least three minutes, with a broad wooden paddle.

"It is now necessary to determine whether the mixture is perfect—that is, if it will be safe to apply it to tender foliage. To accomplish this, two simple tests may be used. First insert the blade of a penknife in the mixture, allowing it to

remain there for at least one minute. If metallic copper forms on the blade, or, in other words, if the polished surface of the steel assumes the color of copper plate, the mixture is unsafe and more lime must be added. If, on the other hand, the blade of the knife remains unchanged, it is safe to conclude that the mixture is as perfect as it can be made. As an additional test, however, some of the mixture may be poured into an old plate or saucer, and while held between the eyes and the light, the breath should be gently blown upon the liquid for at least half a minute. If the mixture is properly made, a thin pellicle, looking like oil on water, will begin to form on the surface of the liquid. If no pellicle forms, more milk of lime should be added."

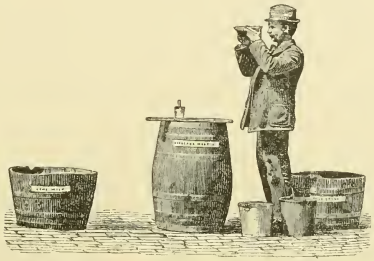

FIG. 4.—Testing the Bordeaux mixture by the plate method.

The Bordeaux mixture should be applied with a pump designed especially for spraying. Such pumps may be obtained of almost any hardware dealer. In spraying, it is necessary to keep the mixture thoroughly stirred. Only freshly made mixture should be used.

Bordeaux Mixture in a Dry Form.—This, in the form known as "Fungroid," has not proved satisfactory with us. The potato vines, to which it was applied, showed little, if any, benefit from its use. It is doubtful if any fungicide in a powdered form will be as efficient as a liquid one.

HOW TO SPRAY

In Bulletin 101 of the Cornell Experiment Station, Prof. L. H. Bailey, among many other things worth quoting, says, in

regard to spraying : " Spray thoroughly or not at all. I should say that fully half the spraying which I have seen in western New York in the last two or three years is a waste of time and material. Squirting a few quarts of water at a tree as you hurry past it, is not spraying A tree is thoroughly and honestly sprayed when it is *wet all over*, on all the branches and on both sides of all the leaves. An insect or fungus is not killed until the poison is placed where the pest is." Again he says: " The farmer should know what he wants to kill, before he begins to spray. It is common to find a man who is going at spraying with enthusiasm, but who cannot explain a single definite object which he has in view. He simply knows upon general principles that spraying is useful. To such a man, spraying is spraying, whether he uses Paris green or Bordeaux, or both, or neither one; and his results are about equal to his knowledge. There is no longer excuse for such ignorance, for all the leading insects and fungi have received more or less exact treatment in the publications of the experiment stations."

WHEN TO SPRAY WITH BORDEAUX MIXTURE

For Scab and Other Fungous Diseases of the Apple and Pear.—Spray once before the blossoms open, and again as soon as the blossoms fall, and a third time two weeks later.

For Black Knot on Plum.—Spray once before the buds begin to swell, and again just before they burst. These sprayings are directed against the winter spores. For the summer spores, spray the last of May and again about the middle of June.

For Early Blight on Early Potatoes.—Spray when the vines are about two thirds grown, and a second time two weeks later.

For Both Early and Late Blight on Late Potatoes.—Spray three times: the middle of July, the first of August, and the middle of August.

Rainy weather may render it advisable to spray at shorter intervals, and to increase the number of sprayings.

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